Special Relativity - Summary 4

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This summary is based on the book chapters A1-A3 and B1-B5 of Robert Resnick: Introduction to Special Relativity

1 Space-Time Diagrams

In special relativity space and time are closely related, which is also reflected in the Lorentz transformations. One way to represent this close relation is space time diagrams, which were developed by the mathematician Herman Minkowski. These diagrams are a geometrical representation of space-time. Typically the diagrams are simplified to one spatial axis (e.g. x-axis) and one time axis (e.g. w=ct axis).

2 The twin paradox

The setup: There is a pair of twins, where one of the twins remains stationary (e.g. on Earth) and the other twin travels away in a very fast spaceship to a certain distance and then returns to Earth. When the twins are together again, they find that the one that stayed on Earth is older compared to the one that has travelled.

The paradox: Shouldn't the position of the twins be interchangeable if motion is relative? Could we not just assume that Earth was moving compared to the "travelling" twin?

Explanation: The situation is not symmetric. The stationary twin remained in one inertial frame the whole time, while the travelling twin has been in two different inertial frames. One frame while going away and a different frame while returning. The travelling twin has moved along a certain path with a certain velocity and time has been dilated for this twin $\rightarrow$ twin is younger

2.1 Experimental test

Two identical amounts of **radioactive material** on a rotor, where one sample of the radioactive material is stationary and the other one is moving. If the material is identical (e.g. uranium), then they have the same half life and the same amount of material should decay in a unit length of time. The experimental results show that the moving sample has decayed less compared to the stationary sample.